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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
10/761,256	01/22/2004	Takashi Tonegawa	Q79466	2575

23373 7590 07/12/2006

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EXAMINER

NGUYEN, THANH T

ART UNIT PAPER NUMBER

2813

DATE MAILED: 07/12/2006

Please find below and/or attached an Office communication concerning this application or proceeding.

## Office Action Summary

Application No.

10/761,256

Applicant(s)

TONEGAWA, TAKASHI

Examiner

Thanh T. Nguyen

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— The MAILING DATE of this communication appears on the cover sheet with the correspondence address —

### Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) OR THIRTY (30) DAYS, WHICHEVER IS LONGER, FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

### Status

- 1) ☒ Responsive to communication(s) filed on 08 May 2006.
- 2a) ☐ This action is **FINAL**. 2b) ☒ This action is non-final.
- 3) ☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

### Disposition of Claims

- 4) ☒ Claim(s) 1-13 is/are pending in the application.
- 4a) Of the above claim(s) 7-11 is/are withdrawn from consideration.
- 5) ☐ Claim(s) \_\_\_\_\_ is/are allowed.
- 6) ☒ Claim(s) 1-6, 12 and 13 is/are rejected.
- 7) ☐ Claim(s) \_\_\_\_\_ is/are objected to.
- 8) ☐ Claim(s) \_\_\_\_\_ are subject to restriction and/or election requirement.

### Application Papers

- 9) ☐ The specification is objected to by the Examiner.
- 10) ☐ The drawing(s) filed on \_\_\_\_\_ is/are: a) ☐ accepted or b) ☐ objected to by the Examiner.
- Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).
- Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).
- 11) ☐ The oath or declaration is objected to by the Examiner. Note the attached Office Action or form PTO-152.

### Priority under 35 U.S.C. § 119

- 12) ☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).
- a) ☐ All b) ☐ Some \* c) ☐ None of:
1. ☐ Certified copies of the priority documents have been received.
2. ☐ Certified copies of the priority documents have been received in Application No. \_\_\_\_\_.
3. ☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

\* See the attached detailed Office action for a list of the certified copies not received.

### Attachment(s)

- 1) ☐ Notice of References Cited (PTO-892)
- 2) ☐ Notice of Draftsperson's Patent Drawing Review (PTO-948)
- 3) ☒ Information Disclosure Statement(s) (PTO-1449 or PTO/SB/08)
- Paper No(s)/Mail Date 5/8/06.

- 4) ☐ Interview Summary (PTO-413)
- Paper No(s)/Mail Date. \_\_\_\_\_.
- 5) ☐ Notice of Informal Patent Application (PTO-152)
- 6) ☐ Other: \_\_\_\_\_.

## **DETAILED ACTION**

### ***Request for Continued Examination***

The request filed on 5/8/06 for a Request for Continued Examination (RCE) under 37 CFR 1.114 is acceptable and an RCE has been established. An action on the RCE follows.

### ***Information Disclosure Statement***

The information disclosure statement filed 5/8/06 has been considered.

### ***Claim Rejections - 35 USC § 102***

The following is a quotation of the appropriate paragraphs of 35 U.S.C. 102 that form the basis for the rejections under this section made in this Office action:

A person shall be entitled to a patent unless –

(b) the invention was patented or described in a printed publication in this or a foreign country or in public use or on sale in this country, more than one year prior to the date of application for patent in the United States.

(e) the invention was described in (1) an application for patent, published under section 122(b), by another filed in the United States before the invention by the applicant for patent or (2) a patent granted on an application for patent by another filed in the United States before the invention by the applicant for patent, except that an international application filed under the treaty defined in section 351(a) shall have the effects for purposes of this subsection of an application filed in the United States only if the international application designated the United States and was published under Article 21(2) of such treaty in the English language.

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Claims 1-6 are rejected under 35 U.S.C. 102(e) as being anticipated by Chambers et al. (U.S. Patent No. 2003/0137050).

Referring to figures 1-8, Chambers et al. teaches a semiconductor device comprising :  
a first Cu interconnection (see figure 1) including additive metal atoms (see paragraphs# 26, 32) and additive silicon atoms (see paragraphs# 35, 47, 58),

wherein a density of said additive metal atoms is higher in vicinities of bottom and side surfaces of said first Cu interconnection than in a vicinity of a top surface (see paragraphs# 26, 32) thereof,

wherein a density of said additive silicon atoms is higher in said vicinity of said top surface than in said vicinities of said bottom and side surfaces (see paragraphs# 35, 47, 58), and

Wherein the density of the additive silicon atoms ranges between 0.01 atomic % and 8 atomic % of total atoms in the first Cu interconnection (see paragraph# 35, 200-900ppm of silicon = 0.03-0.09 atomic percent silicon).

Noted that the same process would provide the same results such that seed layer is formed comprising copper and other alloy metals and anneal at the temperature of 200-400°C. and exposing the copper (conductive) layer with silane and annealing at the temperature of 300-450 to prevent the formation of silicide to improve electromigration reliability (see paragraphs# 26/32, 35/47/58).

Regarding to claim 2, additive metal atoms include atoms of one or more of metals selected from the group consisting of Al, Sn, Ti, Si, In, Ag, Zr, Ni, Mg, Be, Pd, Co, B, Zn, Ca, Au and Ga (see paragraph# 26).

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Regarding to claim 3, a second Cu interconnection (see figure 1, metallization layer 1) overlying said first Cu interconnection (metallization layer 2) and including additive metal atoms and additive silicon atoms, wherein a density of said additive metal atoms in said second Cu interconnection is higher in vicinities of bottom and side surfaces of said first Cu interconnection than in a vicinity of a top surface thereof, and a density of said additive silicon atoms in said second Cu interconnection is higher in said vicinity of said top surface than in said vicinities of said bottom and side surfaces (see figure 1-8, paragraphs# 26/32, 35/47/58).

Regarding to claim 4, additive metal atoms in said second Cu interconnection include atoms of one or more of metals selected from the group consisting of Al, Sn, Ti, Si, In, Ag, Zr, Ni, Mg, Be, Pd, Co, B, Zn, Ca, Au and Ga (see paragraph# 26).

Regarding to claim 5, second Cu interconnection includes a Cu interconnection line and a via plug extending from said Cu interconnection line and connected to said first Cu interconnection (see figure 1).

Regarding to claim 6, the first Cu interconnection and said second Cu interconnection are connected together via a Cu plug covered with a barrier metal film (300, see figure 1+).

### ***Claim Rejections - 35 USC § 103***

The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

(a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negated by the manner in which the invention was made.

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Claim 12-13 rejected under 35 U.S.C. 103(a) as being unpatentable over Chamber et al. (U.S. (U.S. Patent No. 2003/0137050) as applied to claims 1-6 above in view of an ordinary skill in the requisite art.

Chamber teaches forming a copper layer wherein the bottom of the copper has more additive metal atoms than the top surface and the top surface has more silicon atom with ring the range or 0.03-0.09 atomic percent than the bottom surface. However, the reference does not teach the density of the additive silicon atoms at the bottom surface is 0.01 atomic % and top surface of the copper is 8 atomic % of total atoms.

It would have been obvious to a person of ordinary skill in the requisite art at the time of the invention was made to optimize the additive silicon atom in the copper layer, since it has been held that where the general conditions of a claim are disclosed in the prior art (i.e.- density of the additive silicon atoms at the bottom surface is 0.01 atomic % and top surface of the copper is 8 atomic % of total atoms), discovering the optimum or workable ranges involves only routine skill in the art. In re Aller, 105 USPQ 233 (CCPA 1955).

The specification contains no disclosure of either the critical nature of the claimed arrangement (i.e.- wherein the density of the additive silicon atoms at the bottom surface is 0.01 atomic % and top surface of the copper is 8 atomic % of total atoms) or any unexpected results arising therefrom. Where patentability is said to be based upon particular chosen limitations or upon another variable recited in a claim, the applicant must show that the chosen limitations are critical. In re Woodruff, 919 F.2d 1575, 1578 (FED. Cir. 1990).

Therefore, it would have been obvious to a person of ordinary skill in the requisite art at the time of the invention was made would form the copper layer having the bottom surface of

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0.01 atomic % of silicon and the top surface of 8 atomic % of silicon in process of Chambers et al. because the process would improve electromigration reliability.

***Conclusion***

Any inquiry concerning this communication or earlier communications from the examiner should be directed to Thanh Nguyen whose telephone number is (571) 272-1695, or by Email via address Thanh.Nguyen@uspto.gov. The examiner can normally be reached on Monday-Thursday from 6:00AM to 3:30PM.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Carl Whitehead, can be reached on (571) 272-1702. The fax phone number for this Group is (703) 872-9306.

Any inquiry of a general nature or relating to the status of this application or proceeding should be directed to the Group receptionist whose telephone number is (703) 308-0956 (See MPEP 203.08).



Thanh Nguyen  
Patent Examiner  
Patent Examining Group 2800

TTN